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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of
Masato SHIMADA, et al.

Docket No: Q52241

#36/Appeal Brief

Appln. No.: 09/199,816

Group Art Unit: 2855

Confirmation No.: 4106

Examiner: C. Dickens

Filed: November 25, 1998

For: INK JET RECORDING HEAD AND INK JET RECORDER

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SUBMISSION OF APPELLANTS' BRIEF ON APPEAL

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith please find an original and two copies of Appellants' Brief on Appeal. A check for the statutory fee of $320.00 is attached. The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account. A duplicate copy of this paper is attached.

Respectfully submitted,

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Date: June 4, 2003

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APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the provisions of 37 C.F.R. § 1.192, Appellants submit the following:

I REAL PARTY IN INTEREST

The real party in interest is Assignee Seiko Epson Corporation, of Japan.

II RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellants, the Appellants' legal representative, or Assignee which will directly affect or be directly effected by or have a bearing on the Board's decision in the pending appeal.

III STATUS OF CLAIMS

Claims 1-67 are pending in this application, and their status is as follows.

Claims 1-55 and 64-67 are rejected and are the subject of this appeal.

Claims 56-63 have been withdrawn from consideration by the Examiner as being drawn to a non-elected invention, and are not the subject of this appeal.

IV STATUS OF AMENDMENTS

Appellants filed, on March 10, 2003, a response to the final Office Action as mailed on September 11, 2002. However, the March 10 response made no amendments to the claims. Accordingly, the claims stand as presented before the September 11 final Office Action.

V SUMMARY OF THE INVENTION

The present invention is directed to an ink jet recording head wherein some of the pressure generation chambers, communicating with nozzle openings for jetting ink drops, are formed of a diaphragm and a surface of the diaphragm is formed with a piezoelectric element for jetting ink drops by displacement of the piezoelectric element and, accordingly, the diaphragm.[1] More specifically, with reference to Figs. 1, 2(b), and 6(a)-(c), one embodiment of the invention is, in an ink jet recording head of the type having

a flow passage formation substrate 10 in which a pressure generation chamber 12 is formed, the pressure generation chamber 12 being in communication with a nozzle opening 11,

a diaphragm 50, 60 provided on the flow passage formation substrate 10, the diaphragm 50, 60 defining an interior wall of the pressure generation chamber 12, and

a piezoelectric element 300 provided on said diaphragm 50, 60, said piezoelectric element having at least a lower electrode 60, a piezoelectric layer 70, and an upper electrode 80, the improvement comprising:

at least one of the group consisting of the diaphragm 50, 60 and the piezoelectric element 300, includes a compression film 50 having a compressive stress σ_4, wherein at least a part of a thickness of the compression film 50 is removed in an area opposed to the pressure generation

[1] Specification at page 1, 1st full paragraph.

chamber 12, thereby forming a removal part 350. See also, page 11, 6th paragraph to page 13, 2nd paragraph.

In this type of record head, the piezoelectric element acts in a deflection vibration mode to put pressure on the diaphragm to squeeze ink out of the ink chamber and through the nozzle onto the recording medium.[2] However, in the previously known thin film patterning methods for forming the diaphragm, piezoelectric member, and pressure chambers, the diaphragm was initially deflected to the pressure chamber side by the force f, which is the effect of the internal stresses of the films. See Figs. 7(b), 8(b), and the specification at the paragraph bridging pages 1 and 2. With such an arrangement, the diaphragm is subject to a possible plastic deformation when an additional force F is applied to the diaphragm by the piezoelectric element. See, again, Fig. 8(b). And if the diaphragm undergoes plastic deformation, thereafter it will not function effectively to jet ink from the nozzle with which it is associated.

It is thus an object of the invention to provide an ink jet recording head with a decreased amount of initial deflection.[3] Embodiments of the present invention achieve this reduced diaphragm-initial-deflection by providing at least one of the diaphragm and the piezoelectric element with a compression film 50 having a compressive stress σ_4, wherein at least a part of a thickness of the compression film 50 is removed in an area opposed to the pressure generation chamber 12, thereby forming a removal part 350. The specification describes one manner in which the compression film—having a compressive stress—is formed. See, for example, page 13, 3rd full paragraph to page 15 last full paragraph. Although the process for making the diaphragm and piezoelectric element are not a part of the presently claimed invention, an understanding thereof helps one to understand the present invention. Thus, as shown in Figs. 6(a) - 6(c), because the compressive stress σ_4 in the elastic film 50 is made to balance—via formation of removal part 350—the stresses σ_1-σ_3 in the elements 60, 70, 80, of the piezoelectric element 300, the initial

[2] Specification at page 1, 2nd, and 4th to 6th paragraphs.

[3] Specification at page 2, 1st to 3rd full paragraphs.

deformation of the diaphragm is greatly reduced, or eliminated, when the pressure generation chamber 12 is formed. Accordingly, as shown in Fig. 8(a), when deformation force F is applied to the diaphragm to jet ink, the diaphragm desirably remains in its elastic deformation area. See, also, page 16, 3rd full paragraph, as well as the paragraph bridging pages 16 and page 17.

VI ISSUES

Issue 1 Whether claims 1-55 and 64-67 are unpatentable under § 103(a) over US Patent 5,212,496 to Badesha in view of US Patent 5,124,716 to Roy et al.

VII GROUPING OF CLAIMS

Issue 1 Claims 1-55 and 64-67 stand or fall together.

VIII ARGUMENTS

The Examiner rejected claims 1-55 and 64-67 under §103(a) as being unpatentable over US Patent 5,212,496 to Badesha et al. (hereinafter Badesha) in view of US Patent 5,124,716 to Roy et al. (hereinafter Roy). Applicants respectfully traverse this rejection because the references fail to establish *prima facie* obviousness in that they do not teach or suggest every element as set forth in Applicants' claims.

First, Applicants' arguments as set forth in the Amendment filed July 1, 2002, on pages 2-5, are still pertinent and, therefore, are incorporated herein by reference.

One embodiment of the present invention relates to an ink jet recording head for jetting ink drops via the displacement of a piezoelectric element. With reference to Fig. 2, the ink jet recording head is of the type having a flow passage formation substrate 10 in which a pressure generation chamber 12 and a nozzle opening 11 are formed. A diaphragm 50 is provided on the flow passage formation substrate 10. The diaphragm 50 defines an interior wall of the pressure generation chamber 12. A piezoelectric element 300 is provided on the diaphragm 50. The piezoelectric element 300 has a lower electrode 60, a piezoelectric layer 70, and an upper electrode 80.

As recited in claim 1, an important feature of the present invention is that the ink jet recording head includes a compression film having (i) a compressive stress and (ii) at least a part in a thickness direction removed in an area opposed to the pressure generation chamber 12, thereby forming a removal part 350. The compression film may form a variety of elements in the ink jet recording head depending on the particular embodiment. For example, Fig. 6 shows the compression film forming the elastic wall 50 (or diaphragm), Fig. 16 shows the compression film forming the lower electrode 60, Fig. 18 shows the compression film forming the upper electrode 80, and Fig. 24 shows the compression film forming the conductive film 65.

The Examiner asserts that Badesha teaches all of the features set forth in claim 1, except for a piezoelectric driver. More specifically, the Examiner asserts that at least one of a diaphragm (col. 11, lines 7-61) and an acoustic heating driver element 34, includes a compression film having a compressive stress.[4] But the Examiner's interpretation of Badesha is, respectfully, wrong.

Contrary to the Examiner's assertion, col. 11, lines 7-61 merely discloses various films such as, for example, silicon dioxide thermal oxide layer 17, thick film type insulative layer 18, and passivation layer 16. However, Badesha does not teach or suggest that any of these films is a compression film, or that any of these films includes a compressive stress.

Further, Badesha discloses that the acoustic heating driver elements 34 are patterned on surface 30 of the heating element plate 28, and are positioned in each channel formed by grooves in the lower substrate or heater plate.[5] Again, Badesha does not teach or suggest that these heating driver elements, or the layers on which they are disposed, are a compression film, or even include a compressive stress. In fact, Badesha does not even use the terms "compression film" or "compressive stress" anywhere through his specification.

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[4] Office Action at page 2, item 3, paragraph 2.

[5] Badesha at col. 9, line 53 - col. 10, line 26.

Thus, with respect to the compression film having a compressive stress, the Examiner's position is speculative at best. Of course the Examiner may be relying upon an inherency theory, but if this were the case, then she should have at least set forth a cogent line of technical reasoning as to why the relied upon layers in Badesha would necessarily have a compressive stress. In this case, the Examiner has not provided any reasoning whatsoever. At least in this respect, the Examiner has not even established a *prima facie* case of obviousness.

Moreover, the specification indicates that the compressive stress is achieved via specific processing steps. For example, when the compression film forms the elastic film 50, a zirconium layer is formed on the substrate by sputtering, and then thermal oxidation processing occurs in oxygen at a high temperature to achieve a monoclinic system. During oxidation, the zirconium is heated to a phase transition temperature or more. Therefore, when cooled, a transition occurs resulting in the zirconium oxide having a compressive stress.[6] The specification also provides the processing details to achieve the compressive stress when the compression film forms other layers in the ink jet recording head.[7]

By sharp contrast to the present invention, Badesha does not indicate any specific processing steps that would lead to a compressive stress in the relied upon layers. Rather, Badesha merely indicates the locations of these layers, their respective functions (which do not include providing a compressive stress), and exemplary materials that may be used to form the layers. Certainly then, the compressive stress feature defined by claim 1 is not at all taught or suggested by Badesha. The Examiner's assertions to the contrary are simply unfounded.

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[6] Specification, paragraph bridging p. 13-14.

[7] When the compression film forms the lower electrode 60, see p. 21, 1st paragraph. When the compression film forms the upper electrode 80, see p. 22, 5th and 6th paragraphs.

The Examiner then cites Roy as teaching a piezoelectric driver. But Roy does not at all teach or suggest a compression film having a compressive stress, let alone that such is one of a diaphragm and a piezoelectric element, as set forth in claim 1.

Therefore, for the sake of argument, even assuming that one of ordinary skill in the art were motivated to combine Badesha and Roy as suggested by the Examiner, any such combination would still not teach or suggest all the elements as set forth and arranged in Applicants' claim 1.

Second, the Examiner asserts that Applicants have not presented any "evidence, i.e. 37 CFR 1.132" that the materials used by the prior art do not have a compressive stress as compared to the materials used by the Applicants.[8] However, because the Examiner has failed even to establish *prima facie* obviousness, Applicants are under no obligation to present any evidence of non-obviousness. Specifically, because the Examiner has not presented any teaching or suggestion of a compression film having a compressive stress, as claimed, Applicants are under no obligation to present evidence that the references do not teach or suggest such an element.

Nonetheless, Applicants have presented—in the Amendment filed on January 10, 2002—articles explaining that not all materials include a compressive stress. Although some materials exhibit compressive stress, other materials exhibit tensile stress, whereas still others exhibit no internal stress; all stress is not compressive. Note Figs. 1a and 1b in the article by B. Stein entitled "A Practical Guide to Understanding, Measuring and Controlling Stress in Electroformed Metals", submitted with the January 10, 2002 Amendment. Further, as noted in the article entitled "Applications" by the Residual Stress User Center—also submitted with the January 10, 2002 Amendment—residual stresses originate from differential plastic flow, differential cooling rates, or phase transformations with volume changes. These stresses can be

[8] September 11 Office Action at page 2, item number 4.

created by welding, forging, casting, rolling, machining, surface treatments, or heat treating.[9] And stresses that develop in composites primarily result from differences in the respective thermal expansion coefficients.[10]

Therefore, the Examiner's assertion that "all materials have compressive stress" is mistaken. And because neither Badesha nor Roy teaches or suggests the use of a compression film having a compressive stress, the combination thereof does not render obvious Applicants' claims.

As further evidence that not all films include a compressive stress, Applicants submitted, with the March 10, 2003 Response, an article entitled "Stresses in Pt/Pb(ZrTi)O_3/Pt thin-film stacks for integrated ferroelectric capacitors", by G.A.C.M. Spierings et al., Journal of Applied Physics, vol. 78 (3), August 1, 1995, pp. 1926-1933 (hereinafter Spierings).

Spierings teaches that several different stresses, such as intrinsic stress and thermal stress, can be present in a thin film. Spierings goes on to teach that the magnitude of the intrinsic stress is largely determined by the deposition conditions—i.e., how the film was made—and change upon annealing. See, for example, page 1927, right column, 1st full paragraph to page 1928, end of left column. Additionally, with respect to the platinum bottom electrode, Spierings specifically teaches that the "stress in a sputtered metal film can be varied over a wide range, from tensile to compressive, by modifying sputter conditions such as pressure and power."[11] Further, with respect to the stresses in the PZT film, Spierings teaches that a first PZT layer is compressive, whereas two subsequent layers are increasingly tensile.[12] Moreover, Spierings teaches that the stresses in each of the electrodes and PZT film changed from compressive to

[9] See "Applications" at page 1, 1st paragraph.

[10] See "Applications" at page 1, 2nd paragraph.

[11] Spierings at page 1928, right column, paragraph carrying over to page 1929.

[12] Spierings at page 1929, right column, last paragraph, carrying over to page 1930.

tensile, or vise versa, upon annealing. See, for example, Table III, and the paragraph bridging pages 1930-1931. Also, see section VI. Discussion and Conclusions on pages 1932-1933.

In light of the above, Applicants have shown that it is readily known within the skill of the art that not all materials include a compressive stress, and that the stress profile of a material depends upon how it was made, and to what annealing treatments it was subjected. Accordingly, the Examiner's assertion that Badesha includes a compressive stress is in error. That is, as noted in the first argument, above, Badesha does not use the terms "compressive" or "compression" at all, and further does not disclose any particular process by which his films are made. Therefore, Badesha contains no teaching or suggestion of a compression film having a compressive stress, as claimed.

In contrast to that in the references cited by the Examiner, the present invention is characterized by a feature in which a film having a compressive stress is removed at a certain location to cancel (or release) a residual stress to thereby avoid the undesired deformation of the film and improve the performance of the piezoelectric element. See, for example, the second paragraph of page 15 in the present specification.

For at least any of the above reasons, the Examiner's rejection based on Badesha and Roy is in error, and should be withdrawn.

Conclusion

The present Brief on Appeal is being filed in triplicate. Unless a check is submitted herewith for the fee required under 37 C.F.R. §1.192(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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Date: June 4, 2003

APPENDIX

Claims 1-55 and 64-67 on Appeal:

1. In an ink jet recording head of the type having

a flow passage formation substrate in which a pressure generation chamber is formed, said pressure generation chamber being in communication with a nozzle opening,

a diaphragm provided on said flow passage formation substrate, said diaphragm defining an interior wall of said pressure generation chamber, and

a piezoelectric element provided on said diaphragm, said piezoelectric element having at least a lower electrode, a piezoelectric layer, and an upper electrode, the improvement comprising:

at least one of the group consisting of said diaphragm and said piezoelectric element, includes a compression film having a compressive stress, wherein at least a part of a thickness of said compression film is removed in an area opposed to said pressure generation chamber, thereby forming a removal part.

2. The ink jet recording head as claimed in claim 1 wherein the compression film is other than the piezoelectric layer.

3. The ink jet recording head as claimed in claim 1, wherein the compression film has at least a part in the thickness direction removed only in a portion along margins of the pressure generation chamber on both sides of said piezoelectric element in a width direction thereof.

4. The ink jet recording head as claimed in claim 1, wherein the compression film is a conductive film being placed between the lower electrode and the piezoelectric layer and made of a material substantially different from that of the lower electrode.

5. The ink jet recording head as claimed in claim 4, wherein the conductive film is a film containing a second conductive film formed on the lower electrode and a first conductive film formed on the second conductive film and at least the second conductive film is a film made of a material different from that of the lower electrode.

6. The ink jet recording head as claimed in claim 5 wherein the second conductive film is a film comprising either platinum or iridium.

7. The ink jet recording head as claimed in claim 5, wherein the second conductive film is a metal oxide film.

8. The ink jet recording head as claimed in claim 7, wherein the first conductive film is a film formed of a material for preventing lead contained in the piezoelectric layer from diffusing.

9. The ink jet recording head as claimed in claim 7, wherein the second conductive film comprises any of iridium oxide, rhenium oxide, or ruthenium oxide.

10. The ink jet recording head as claimed in claim 1, wherein the compression film forms at least a part of an elastic film forming at least a part of the diaphragm.

11. The ink jet recording head as claimed in claim 10 wherein at least the residue of the compression film forming a part of the elastic film is made of a polycrystalline substance.

12. The ink jet recording head as claimed in claim 11, wherein the elastic film is made of the compression film only.

13. The ink jet recording head as claimed in claim 11, wherein the elastic film is made of a film of multiple layers and at least the top layer is the compression film.

14. The ink jet recording head as claimed in claim 13, wherein the compression film forming the elastic film is made of metal oxide.

15. The ink jet recording head as claimed in claim 14 wherein the compression film is made of zirconium oxide or hafnium oxide and has a crystal structure of a monoclinic system.

16. The ink jet recording head as claimed in claim 13, wherein a layer below the compression film is a layer made of a material different from the compression film in etching characteristic and is not selectively etched.

17. The ink jet recording head as claimed in claim 16, wherein the not selectively etched layer below the compression film is selected from metal, stabilization or partial stabilization zirconium oxide, and stabilization or partial stabilization hafnium oxide.

18. The ink jet recording head as claimed in claim 10, wherein the lower electrode is made of a film having a tensile stress and is thinner than the compression film of the portion with at least a part removed.

19. The ink jet recording head as claimed in claim 13, wherein the elastic film contains a silicon dioxide film or a boron-doped silicon film on the pressure generation chamber side.

20. The ink jet recording head as claimed in claim 1, wherein the lower electrode is made of the compression film.

21. The ink jet recording head as claimed in claim 20 wherein the lower electrode is made of a metal material.

22. The ink jet recording head as claimed in claim 20 wherein the lower electrode is made of metal oxide.

23. The ink jet recording head as claimed in claim 20 wherein the lower electrode is made of metal nitride.

24. The ink jet recording head as claimed in claim 20, wherein the lower electrode on both sides of the piezoelectric layer in a width direction thereof is completely removed.

25. The ink jet recording head as claimed in claim 1, wherein the upper electrode is formed of the compression film and is patterned together with the piezoelectric layer.

26. The ink jet recording head as claimed in claim 25 wherein the upper electrode made of the compression film has a compressive stress at least after said piezoelectric element is patterned.

27. The ink jet recording head as claimed in claim 26 wherein the upper electrode comprises a metal material.

28. The ink jet recording head as claimed in claim 27 wherein the upper electrode made of the compression film is formed by a sputtering method and a predetermined gas is added into the metal material, whereby the upper electrode becomes a compressive stress.

29. The ink jet recording head as claimed in claim 28 wherein the predetermined gas is an inert gas selected from helium, neon, argon, krypton, xenon, and radon.

30. The ink jet recording head as claimed in claim 27 wherein at least one additive selected from metal, semimetal, semiconductor, and insulator different in constituent is added into the metal material, whereby the upper electrode made of the compression film becomes a compressive stress.

31. The ink jet recording head as claimed in claim 30 wherein the additive is added to the upper electrode by executing ion implantation.

32. The ink jet recording head as claimed in claim 30 wherein the additive is added to the upper electrode by executing solid-phase diffusion from a layer placed on the upper electrode.

33. The ink jet recording head as claimed in claim 32 wherein the solid-phase diffusion is executed by heating in an insert gas or in vacuum.

34. The ink jet recording head as claimed in claim 25, wherein the upper electrode has a first electrode formed on a surface of the piezoelectric layer and a second electrode deposited on the first electrode and the second electrode is a film made of metal oxide or metal nitride.

35. The ink jet recording head as claimed in claim 34 wherein the first electrode comprises a metal material.

36. The ink jet recording head as claimed in claim 21, wherein the metal material is selected from platinum, palladium, iridium, rhodium, osmium, ruthenium, and rhenium, and compounds thereof.

37. The ink jet recording head as claimed in claim 14, wherein the metal oxide is selected from ruthenium oxide, indium oxide tin, cadmium indium oxide, tin oxide, manganese oxide, rhenium oxide, iridium oxide, strontium ruthenium oxide, indium oxide, zinc oxide, titanium oxide, zirconium oxide, tantalum oxide, hafnium oxide, osmium oxide, rhodium oxide, palladium oxide, and molybdenum oxide, and compounds thereof.

38. The ink jet recording head as claimed in claim 23, wherein the metal nitride is selected from titanium nitride, niobium nitride, zirconium nitride, tungsten nitride, hafnium nitride, molybdenum nitride, tantalum nitride, chromium nitride, and palladium nitride, and compounds thereof.

39. The ink jet recording head as claimed in claim 37, wherein layers formed of the metal oxide and the metal nitride are formed by oxidation or nitriding after film formation.

40. The ink jet recording head as claimed in claim 1, wherein the elastic film forming at least a part of the diaphragm has at least a part in a thickness direction removed in an area which is opposed to the pressure generation chamber and is other than the piezoelectric layer.

41. The ink jet recording head as claimed in claim 40 wherein the elastic film has at least a part in the thickness direction removed only in a portion along the margins of the pressure generation chamber on both sides of said piezoelectric element in the width direction thereof.

42. The ink jet recording head as claimed in claim 40, wherein said piezoelectric element is formed on the elastic film so as to extend to the portion with at least a part of the elastic film removed.

43. The ink jet recording head as claimed in claim 42 wherein the piezoelectric layer forming said piezoelectric element is roughly uniformly thick.

44. The ink jet recording head as claimed in claim 42 wherein an end of the extension of the piezoelectric layer forming said piezoelectric element to the portion with the part of the elastic film removed is thicker than other portions.

45. The ink jet recording head as claimed in claim 40, wherein at least a part of the piezoelectric layer is formed across an area opposed to the pressure generation chamber and said piezoelectric element is formed by patterning only the upper electrode or the upper electrode and a part of the piezoelectric layer in a thickness direction thereof.

46. The ink jet recording head as claimed in claim 40, wherein the lower electrode is placed uniformly in an area opposed to said piezoelectric element and in other areas.

47. The ink jet recording head as claimed in claim 1, wherein the diaphragm is deformed convex outwardly from the pressure generation chamber.

48. The ink jet recording head as claimed in claim 1, wherein a stress of the piezoelectric layer when a drive force load is imposed on said piezoelectric element is equal to a stress at the piezoelectric layer formation time or is larger in a tension direction.

49. The ink jet recording head as claimed in claim 48 wherein said piezoelectric element in the area opposed to the pressure generation chamber is bent convex to the piezoelectric layer side when the pressure generation chamber is formed.

50. The ink jet recording head as claimed in claim 48, wherein an expansion force of a portion of the diaphragm opposed to said piezoelectric element in the area opposed to the pressure generation chamber is relatively smaller to the compression side than an expansion force in other than the area opposed to said piezoelectric element.

51. The ink jet recording head as claimed in any one of claims 1 to 50 wherein the pressure generation chambers are formed on a silicon monocrystalline substrate by anisotropic etching and the layers of said piezoelectric element are formed by film forming and lithography process.

52. An ink jet recorder comprising an ink jet recording head as claimed in any one of claims 1 to 50.

53. The ink jet recording head as claimed in claim 1, wherein said compression film is an elastic film and said lower electrode film is formed uniformly on said elastic film without patterning.

54. The ink jet recording head as claimed in claim 1, wherein ends of said piezoelectric element are extended to an area opposite to said removal part.

55. The ink jet recording head as claimed in claim 1, wherein said first electrode is said compression film.

64. The ink jet recording head as claimed in claim 4, wherein said conductive film is a metal oxide film.

65. The ink jet recording head as claimed in claim 4, wherein said conductive film is a film formed of a material for preventing lead contained in the piezoelectric layer from diffusing.

66. The ink jet recording head as claimed in claim 65, wherein said material for preventing lead contained in the piezoelectric layer from diffusing is selected from iridium, iridium oxide, ruthenium oxide and rhenium oxide.

67. The ink jet recording head as claimed in claim 1, wherein said compression film includes said compressive stress pre-established therein.